MULTIMEDIA UNIVERSITY

STUDENT ID NO

MULTIMEDIA UNIVERSITY

FINAL EXAMINATION

TRIMESTER 2, 2016/2017

PCM0016 – CHEMISTRY

(All sections / Groups)

1 MARCH 2017
2.30 p.m – 4.30 p.m
(2 Hours)

INSTRUCTIONS TO STUDENT

1. This question paper consists of 4 pages only excluding the cover page.
2. Attempt **ALL** questions. Distribution of the marks for each question is given.
3. Please write all your answers in the answer booklet provided.

QUESTION 1 [20 MARKS]

(a) The two most common and naturally occurring allotropes of carbon are graphite and diamond.

(i) Give the definition of allotropes. [1 mark]

(ii) Draw the crystalline structures of graphite and diamond and complete the properties of graphite and diamond as in the table below. [4 marks]

Property	Graphite	Diamond
Structure		
Electrical conductivity		
Uses		

(b) The three silicon isotopes have atomic masses and relative abundances of 27.9769 amu (92.2297%), 28.9765 amu (4.6832%) and 29.9738 amu (3.0872%). Calculate the atomic mass of silicon. [1.5 marks]

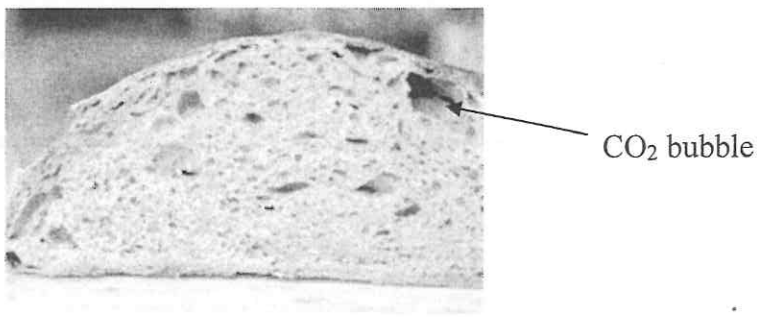
(c) Certain salts of benzoic acid have been used as food additives for decades. The potassium salt of benzoic acid, potassium benzoate ($KC_7H_5O_2$), can be made by the action of potassium permanganate ($KMnO_4$) on toluene (C_7H_8).
[Atomic mass: C = 12; Mn = 55; K = 39; O = 16; H = 1]

$$C_7H_8 + 2\,KMnO_4 \rightarrow KC_7H_5O_2 + 2\,MnO_2 + KOH + H_2O$$

(i) What is the minimum number of grams of toluene needed to produce 10.0 g of $KC_7H_5O_2$? [2 marks]

(ii) Explain why the yield of potassium benzoate cannot realistically be more than the theoretical yield. [1 mark]

(d) A 0.20 mL CO_2 bubble in a bun batter is at 27 °C. In the oven it gets heated to 180 °C. Answer the questions that follow:



(i) Find the volume of the CO_2 bubble right after it gets out from the oven. [1 mark]

(ii) What common ingredient was used to create the original CO_2 bubble and explain the chemistry concept of the formation of bubbles in buns. [1.5 marks]

Continued...

(e) There are two main assumptions about ideal gases that distinguish ideal gases from real gases.
(i) Briefly explain the two main assumptions. [2 marks]
(ii) Write down the corrected formula for the real gases. [1 mark]

(f) If 56.035 L of hydrogen gas reacts with 123.277 L of nitrogen gas to make ammonia gas (NH_3), answer the following:
[Atomic mass: N = 14.0; H = 1.0; R = 0.0821 L·atm/K·mol]
(i) Determine the limiting reagent at STP. [3 marks]
(ii) Calculate how many grams of NH_3 can be produced. [2 marks]

QUESTION 2 [20 MARKS]

(a) When power was turned off to a 50 gallon water heater, the temperature of the water dropped from 80 °C to 25 °C. Calculate the amount of heat lost to the surroundings. [Given that 1 gallon = 3.785 L; density of water is 1.0 g/mL; specific heat of water = 4.186 $J.g^{-1}\,°C^{-1}$] [2.5 marks]

(b) The production of NO (*g*) follows this equation:

$$3\ NO_2\ (g) + H_2O\ (l) \rightarrow 2\ HNO_3\ (aq) + NO\ (g)$$

Given the following thermochemical equations:

$2\ NO\ (g) + O_2\ (g) \rightarrow 2\ NO_2\ (g)$	$\Delta H = -116$ kJ
$2\ N_2\ (g) + 5\ O_2\ (g) + 2\ H_2O\ (l) \rightarrow 4\ HNO_3\ (aq)$	$\Delta H = -256$ kJ
$N_2\ (g) + O_2\ (g) \rightarrow 2\ NO\ (g)$	$\Delta H = +183$ kJ

Calculate the enthalpy:
[Atomic mass: N = 14.0; H = 1.0; O = 16.0]
(i) for the production of NO (*g*). [2 marks]
(ii) per gram of NO (*g*) produced. [1 mark]

(c) The energy of a photon emitted by a hydrogen atom is -4.905×10^{-20} J.
[$R_H = 2.18 \times 10^{-18}$ J; $h = 6.63 \times 10^{-34}$ J.s; $c = 3.00 \times 10^8$ m/s]
(i) Find the wavelength of the photon emitted by the hydrogen atom. [2 marks]
(ii) Determine the initial state of the electron from the hydrogen atom, if it drops to a final state of n = 4. [2 marks]
(iii) Discuss the condition of the electron in (ii) in terms of its stability. [1 mark]

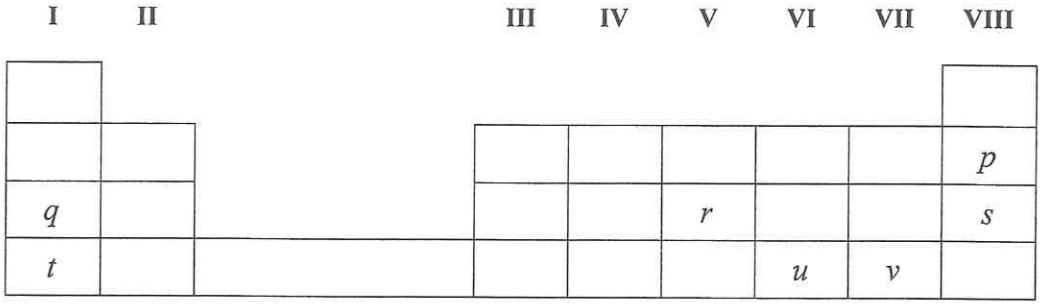
Continued...

(d) Table below shows the incomplete quantum number for electrons *a*, *b*, *c* and *d*. Answer the following:

Electron	n	l	m_l	m_s
a	5	1	1	½
b	3	2	2	-½
c	4	3	-3	½
d	2			

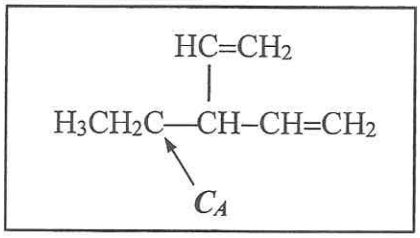
(i) Give the name of electrons *a* and *c*. [1 mark]
(ii) Rank electrons *a*, *b* and *c* in the order of increasing energy (lowest energy first). [1 mark]
(iii) List all the possible values of l and m_l for electron *d*. [1 mark]

(e) The diagram below shows part of the Periodic Table. Answer the questions that follow.



(i) Rank elements *p*, *q*, *r* and *s* in order of increasing first ionization energy. [2 marks]
(ii) Draw the electronic configuration of anion r^{4-}. [1 mark]
(iii) Explain the group and period of *r* in the Periodic Table. [1 mark]
(iv) Which ion is smaller if u^{2-} and v^{-} are isoelectronic? Explain. [1 mark]

(f) For the following compound:



(i) Predict the correct hybridization for the carbon atom, C_A, indicated in the molecule shown. [0.5 mark]
(ii) Determine the number of sigma (σ) bonds and pi (π) bonds in the molecule. [1 mark]

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QUESTION 3 [20 MARKS]

(a) Draw the Lewis structure and complete the table below:

Compound	Lewis structure	AB_nE_m classification	Molecular geometry
CH_2Br_2			
PCl_4^-			

[4 marks]

(b) Calculate the pH of each of the following solutions.
[Atomic mass: Ba = 137.0; H = 1.0; O = 16.0; C = 12.0]

(i) A $Ba(OH)_2$ solution made from 7.06×10^{-3} g $Ba(OH)_2$ and enough water to make 3.0 L of solution. [2 marks]

(ii) 0.3 M HCOOH solution at 25 °C (K_a for HCOOH = 1.8×10^{-4}). [2.5 marks]

(c) One example of an intermolecular force is London force or dispersion force.

(i) Define dispersion force. [1 mark]

(ii) Discuss the strength of dispersion force in H_2 and I_2. [1.5 marks]

(d) The rate equation for the decomposition of a compound *N* has a rate constant of 4.31×10^3 s^{-1} at 600 K and 1.78×10^4 s^{-1} at a temperature *T*. Use this information to deduce the overall order of reaction and whether temperature *T* is greater or smaller than 600 K. [2 marks]

(e) The half-life for the second order reaction below is 20 minutes.

$$X \rightarrow Y$$

Calculate the rate constant, *k* and the time needed for the original amount of the reactant, *X* to drop to become 20% of its original amount. [2 marks]

(f) Consider the following reaction at 200 K:

$$NO_2\,(g) + N_2O\,(g) \rightleftharpoons 3\,NO\,(g)$$

If the equilibrium concentrations are $[NO_2]$ = 3.5 M, $[N_2O]$ = 5.9 M and [NO] = 0.4 M, [R = 0.0821 L·atm/K·mol]

(i) What is the value of the equilibrium constant, K_p? [2 marks]

(ii) If [NO] is removed from the system at equilibrium, which direction will the reaction shift? [1 mark]

(iii) If the system above is endothermic, state to which direction the system will favour. Explain your answer. [2 marks]

End of Paper